

versines, these valuable tables being thus now readily accessible. The author also includes short tables of refraction and dip, sufficient for beginners in navigational astronomy. There is a brief description of the use of the tables, and a five-page collection of useful numbers and physical constants. The tables are carefully compiled and skilfully arranged, and seem thoroughly serviceable and trustworthy.

STATICS IN THE MIDDLE AGES.

Les Origines de la Statique. By P. Duhem. Vol. i. Pp. iv+360. (Paris: A. Hermann, 1905.) Price 10 francs.

THIS book is sure to arouse the interest of all who study the history of natural science, and it may cause a certain amount of controversy owing to the nature of its conclusions; but even if some of these have to be modified, enough will remain to shed a new light on the progress of mechanics in the middle ages. The main result, and this is established beyond all reasonable doubt, is that the mechanics of the fifteenth and sixteenth centuries must not be regarded as a sudden achievement, but as a development of ideas current in the thirteenth and fourteenth centuries, many of which were unscrupulously reproduced without acknowledgment.

Who, then, are these predecessors to whom even Galileo and Descartes probably owed more than they ever confessed? In the first place, Jordanus Nemorarius, or more properly Jordanus de Nemore. Nothing is known of his personal history; Moritz Cantor is inclined to identify him with Jordanus Saxo, but Prof. Duhem conjectures that he may have been an Italian, Giordano of Nemi, and this is plausible enough to deserve further investigation. Manuscript evidence tends to show that his works were composed in the twelfth century at latest. Prof. Duhem's researches lead him to the following conclusions about Jordanus and his mediæval successors. Jordanus wrote a treatise of which the proper title seems to have been "*Elementa Jordani super demonstrationem ponderis*"; of this there is a thirteenth-century fragment and a fifteenth-century text apparently complete. He had studied Aristotle, and the "*De ponderoso et levi*" attributed to Euclid; but his treatise seems to be original, and not a translation from the Greek. He discusses the equilibrium of the lever by a method which is essentially that of virtual velocities, and even seems to be on the brink of discovering the infinitesimal calculus.

Jordanus's treatise became classical; it was associated with the "*De canonio*" (attributed to Euclid), and transformed in various ways by commentators without improvement. But there is another work, attributed to Jordanus, "*De ratione ponderis*," which is of still greater interest and importance. It contains the notion of the moment of a force, the correct theory of a bent lever, and the solution of the statical problem of two weights connected by a string and resting on two different inclined planes. Prof. Duhem is probably right in saying that this was not written by Jordanus, but by an unknown successor whom he calls the "precursor of Leonardo da Vinci."

The main argument is that some errors of the "*Elementa*" are here corrected. It is not impossible that Jordanus wrote it *after* his other treatise, tacitly amending his previous mistakes; however this may be, the author was familiar with Jordanus's "*Elementa*," and his work is contained in a thirteenth-century MS.

The next great figure to appear on the scene is that of Leonardo da Vinci. It is not very easy to decide how much of theoretical statics Leonardo found out for himself; he had a clear notion of moments, but, on the other hand, his ideas about the composition of forces were vague and incorrect. He does not appear to have added anything essential to what was already known in the thirteenth century; but it is likely enough that his manuscripts suggested valuable ideas to some of those into whose hands they fell.

The later chapters of the book deal with the facts relating to Galileo, Stevinus, Roberval, and Descartes; this period is better known, and it is needless to go into details here. The main point is that, however much we owe to sixteenth-century mathematicians, it is wrong for us to regard them as the founders of an absolutely novel theory of statics; and although this conclusion may somewhat dim our mental picture of the glories of the Renaissance, it will deepen our piety towards those *obscuri viri* who cultivated science and learning when they were most in danger of extinction. It is noteworthy that in other directions, such as the history of painting, the same kind of verdict on the Renaissance appears to be forming.

The teaching of mechanics to average students is a very difficult and often ungrateful task. One is often tempted to lose one's temper, and unfairly blame the pupil for his stupidity. It is a wholesome corrective to think of the slow progress of the theory and of the extraordinary mistakes made in connection with it by men of unusual ability. Thus it took years of controversy to establish the fact that a uniform bar, supported at its centre of mass, is in neutral equilibrium; and it was long taken for granted that a two-pound weight fell to the ground twice as fast as a one-pound weight. G. B. M.

SPECTROSCOPY.

Spectroscopy. By E. C. C. Baly. Pp. xi+568; illustrated. (London: Longmans, Green and Co., 1905.) Price 10s. 6d.

THIS important addition to the well-known series of text-books edited by Sir William Ramsay will be welcomed by all who are interested in the progress of spectroscopy, and especially by students of physics and chemistry who may desire to engage in spectroscopic study and research. The book, indeed, fills a gap in spectroscopic literature which has long existed, providing in a moderate compass a comprehensive guide to modern methods of investigation, the theory of the instruments employed, and the principal results which have been arrived at in the application of spectroscopic methods to chemistry and physics. In each of these departments the explanations are gen-

ally characterised by thoroughness in matters of detail, and are seldom lacking in clearness.

On the practical side of the subject there are ample instructions for the adjustment of apparatus, the production of spectra, and the modes of registration by the eye or photographic plate. Particularly useful are the descriptions of a home-made mounting for the prisms and lenses of a powerful spectrograph, of a mounting for a concave grating, and of the construction and use of vacuum tubes. The methods employed for the infra-red and ultra-violet parts of the spectrum are also ably discussed. The explanation of the reduction of photographic spectra is less satisfactory. The tedious and often uncertain process of identifying the comparison lines of iron described on p. 140 may be greatly simplified by the use of Kayser and Runge's wave-length map of the iron spectrum, especially if the lines due to an impurity of copper in the iron which was employed be first eliminated. Again, the Cornu-Hartmann interpolation formula for the determination of wave-lengths from prismatic spectra cannot properly be described as "cumbersome and laborious" (p. 133). The entire computation may be reduced to a very simple form in which a quarter of an hour's work will give all the constants, and the advantages of this method of reduction, which is, in fact, widely employed, should have been indicated.

Almost for the first time in a text-book an attempt is made to give a connected account of the theory of instruments, including the echelon grating and interference methods for the determination of wave-lengths. Such matters as resolving power and efficiency are very fully dealt with, but in view of Schuster's recent criticisms it is unfortunate that so much space has been devoted to Wadsworth's extension of the theory, and in any case the derivation of the formula for the diffraction image of a slit (p. 73) and of Schuster's expression for purity (p. 317) might have been included with advantage.

Among the results of spectroscopic research which are described, absorption spectra in relation to chemical constitution are well explained, and there is an excellent account of spectrum series, in which the relative merits of the formulæ of Rydberg and Kayser and Runge are well brought out. In the latter section, however, there is a complete absence of illustrations, the introduction of which would have made the whole subject clearer and more attractive to beginners.

Actual errors are remarkably few, but one occurring on p. 387 should be corrected. It is there stated that "Lockyer has throughout considered that the passage from the arc to the spark discharge means a great increase of temperature," whereas, as Sir Norman Lockyer has recently pointed out (*Roy. Soc. Proc.*, vol. lxxvi., p. 145), the "action of electricity" has always been included by him in the term "temperature" in relation to dissociating effects.

The illustrations are numerous, but not always well chosen. Mechanical details of such highly specialised apparatus as that of Schumann for the investigation of spectra in the extreme ultra-violet, and of Rowland's engine for ruling gratings, might well have been replaced by illustrations of more direct use to the

student. Photographs of spectra are notably deficient and might frequently be introduced with advantage, as, for example, in the explanation of comparison spectra (p. 138) and in illustration of the differences between arc and spark spectra (p. 387).

Notwithstanding the few drawbacks to which attention has been directed, the book reflects the greatest credit on its author, and will doubtless do much to stimulate spectroscopic research.

PRECIOUS STONES.

Precious Stones considered in their Scientific and Artistic Relations. By Prof. A. H. Church, F.R.S. Pp. vii + 135. (London: Wyman and Sons, 1905.) Price 1s. 6d.; in cloth 2s. 3d.

THIS well-known handbook of the Victoria and Albert Museum has now reached a second edition. It is difficult to say whether the scientific or artistic side of the work is worthy of the higher praise; certain it is that no work on the subject has better combined the two kinds of information. Within the small compass of this little work, Prof. Church has succeeded in giving the most exact and up-to-date account of the best methods of distinguishing the various gem-stones, so often, by design or accident, mistaken for one another.

The work has been revised and enlarged, and some part of it re-written. That it has been fully brought up to date will be seen by anyone who refers to the accounts given of hiddenite, rhodolite, and kunzite.

An important feature of this book is the recognition it gives to the value, for ornamental and artistic purposes, of many substances not popularly regarded as gem-stones. It is to be regretted that fashion, rather than taste and judgment, play so great a part in determining the use and value of many precious stones. Prof. Church's book may serve the purpose of directing attention to the existence of many exquisitely beautiful but almost entirely neglected minerals. His remarks on the selection, arrangement, cutting, and setting of the various stones are especially valuable. There can be no doubt that the beauty of many of the gem-stones is often, to a great extent, lost by inattention to the necessity of artistic treatment in their setting and surroundings. This question has been the subject of much careful study on the part of Prof. Church, and he writes on it with authority. The catalogue of the collection of precious stones made by the late Rev. C. H. Townshend, and left by him to the nation in 1869, is printed at the end of the book. Any student of gems wishing to make himself acquainted with the chief types, and their methods of cutting and mounting, could not do better, after reading Prof. Church's manual, than to visit the Victoria and Albert Museum and examine the specimens, each of which is described in the catalogue. It is not necessary to point out how greatly the value of our national collections is enhanced when the public can obtain so cheaply a convenient and authoritative handbook, dealing with particular classes of objects exhibited in them, like the work before us.

J. W. J.